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Target Considerations for Inner-Shell Photo-Ionized X-Ray Lasing

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Abstract

We present target design for the inner-shell photo-ionization (ISPI) x-ray laser scheme and discuss the requirements for the ionizing x-ray source in rise time and flux. An investigation of the rapid rise time of x-ray emission from targets heated by an ultrashort-pulse (USP) high-intensity optical laser was conducted for use as the x-ray source for ISPI x-ray lasing. Results of x-ray rise times from instantaneously heated Au rod targets[1] show little benefit for using optical pulse widths less than 30 fs [2]. Modeling using the hydrodynamic/atomic kinetics code LASNEX of a 30 fs USP driving laser with energy of order 1 J incident on a structured Au target composed of vertical rods with diameter of 50 nm predicts sufficient x rays to produce a gain-length product ≈ 10 in C at 45Å. Collisional ionization to the lower lasing level limits the duration of lasing giving a x-ray laser pulse duration of order 60 fs FWHM[3]. Our previous calculations assumed a specified absorbed energy in a skin depth in the rods. Here we are also presenting results for planar targets where the absorption of the USP laser light is determined using a 1-D wave solver in LASNEX. We consider various angles of incident including the effect of super-thermal electrons. These results are compared to structured targets.

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